2015 ICA Call for Proposals

Select one of the following *Seeking Revolutionary Technology to Enable Mars Exploration* categories:

____ Technological Advancement __X__ Cross Discipline Integrated Approach * _____ Process Improvement

Idea Title: *Real Time Radiation Exposure And Health Risks*

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Additional Support: *None*

ICA Project Resources Required:	**JSC/WSTF Contractors Only:**
Procurement (materials and equipment): $ 0 Procurement (contractor support at $80/hr): $ 15K Total: $ 15K	JSC/WSTF Contract No.: NAS 9-02078 NASA COR: Jason Weeks, 3-0438, Jason.weeks-1@nasa.gov, JSC-SA411

☒ As a JSC/WSTF contractor, I have spoken with my NASA support contract's Contracting Officer Representative (COR) and secured his/her agreement to amend the contract to add ICA funding for my project.

ICA Funding Request Amount $10k max. (*See Guidance): $15K TRL: Start: 2 Finish: 4

Human Space Flight Architecture Technology (HAT) Performance Targets Needs Ref. No.: 6.3, 6.4, 6.5,11

I) Idea Summary (150 maximum word limit – use same text as is entered into the ICA Idea Summary)

Radiation from solar particle events (SPEs) poses a serious threat to future manned missions outside of low Earth orbit (LEO). Accurate characterization of the radiation environment in the inner heliosphere and timely monitoring the health risks to crew are essential steps to ensure the safety of future Mars missions. In this project we plan to develop an approach that can use the particle data from multiple satellites and perform near real-time simulations of radiation exposure and health risks for various exposure scenarios. Time-course profiles of dose rates will be calculated with HZETRN and PDOSE from the energy spectrum and compositions of the particles archived from satellites, and will be validated from recent radiation exposure measurements in space. Real-time estimation of radiation risks will be investigated using ARRBOD. This cross discipline integrated approach can improve risk mitigation by providing critical information for risk assessment and medical guidance to crew during SPEs.

Word Count: 149

II) Schedule - Lay out a basic 16-week timeline in Gantt chart format for your project's Period of Performance (POP) based on a start date of May 4, 2015 and finishing August 27, 2015.

Project item	May '15	Jun '15	Jul '15	Aug '15	Sep '15
Project start	⇔				
Total dose and dose rates calculations and validation for 2012 SPEs	←—	—→			
Comparison of different fitting schemes for proton spectrum			←—→		
Organ dose calculation and acute risk calculation				←—→	
Project finish				⇔	
JTWG outbrief					⇔

III) Project's Development Value, Alignment, Approach and Anticipated Outcomes and Future Development:

Brief explanation of the Evolvable Mars Campaign goals and objective to be investigated by your Technological Advancement, Multi-Disciplinary Integration Approach or Process Improvement: *(Describe why this is an important issue and describe how your ICA idea may positively impact the EMC's; Cost, Schedule, or Risk Mitigation aspects).*
(40 Points - Alignment)

Solar particle events (SPEs) occur frequently over the approximately 11-y solar cycle, but are highly episodic and almost unpredictable. During such events, energetic particle flux may increase dramatically over background for a period of several hours to a few days. Besides the risks of cancer and other late health effects to astronauts, the appraisal of acute radiation sickness (ARS) assumes prime importance, particularly in exo-LEO missions, because it can immediately impair performance capabilities of crew and threaten mission success. In order to monitor the energetic particles in inner heliosphere, multiple instruments have been launched into different locations in space. In this project, we plan to develop an approach that can use the particle data from satellites and perform near real-time simulations of radiation exposure and health risks for various exposure scenarios, which can improve risk mitigation by providing critical information for risk assessment and medical guidance to crew during SPEs.

Max. Word Count 150 Current Count 150

How do you intend to investigate your idea? (30 Points - Approach)

The transport codes of HZETRN and PDOSE will be used for real-time dose calculations. Both models have been used to solve the transport of energetic particles through shielding of different materials and thicknesses, but with different approaches. In this project we will investigate a new method to use short interval spectrum of proton flux for dose rate calculation. Dose quanities will be calculated from the energy spectrum and compositions of the particles archived from multiple satellites, and will be compared with in-situ measurements of radiation exposure from recent SPEs. Different fitting schemes, including the Weibull, exponential, and Band functions, as well as the DAF (Distributed Approximating Functionals) method, will be studied. Real-time estimation of ARS will then be investigated using the NASA-developed software ARRBOD.

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What is the intended product deliverable of your ICA activity? (20 Points - Outcome)

The validated models will be an essential module to update ARRBOD, a suite of models currently used for conceptual estimation of ARS during a large SPE by NASA mission planners, radiation shield designers, the mission operations directorate, and space biophysics researchers. Other medical end points for ARS, such as the depression of platelets and white blood cells, as well as skin responses, will also be included in the revised version of ARRBOD. These updates will transition ARRBOD into a product for in-flight risk analysis and medical guidance for future long-duration exo-LEO space travel such as Mars missions.

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How do you propose to further develop your idea following completion of this initial ICA effort?
(10 Points – Follow On)

After finishing this short-term investigation, further work will be carried out to develop user-friendly interfaces that link satellite data inputs, realtime dose calculations, and in-flight radiation risk assessment. Either a web server or a stand-alone computer application with the capability of automatic data streaming will be developed. These updates will be worked in close co-operation with the mission operations group to maximize the benefits to real-time operations during long-duration exo-LEO missions. We will seek internal funding supports from the mission operations directorate and the Space Radiation Program Element (SRPE) of Human Research Program (HRP).

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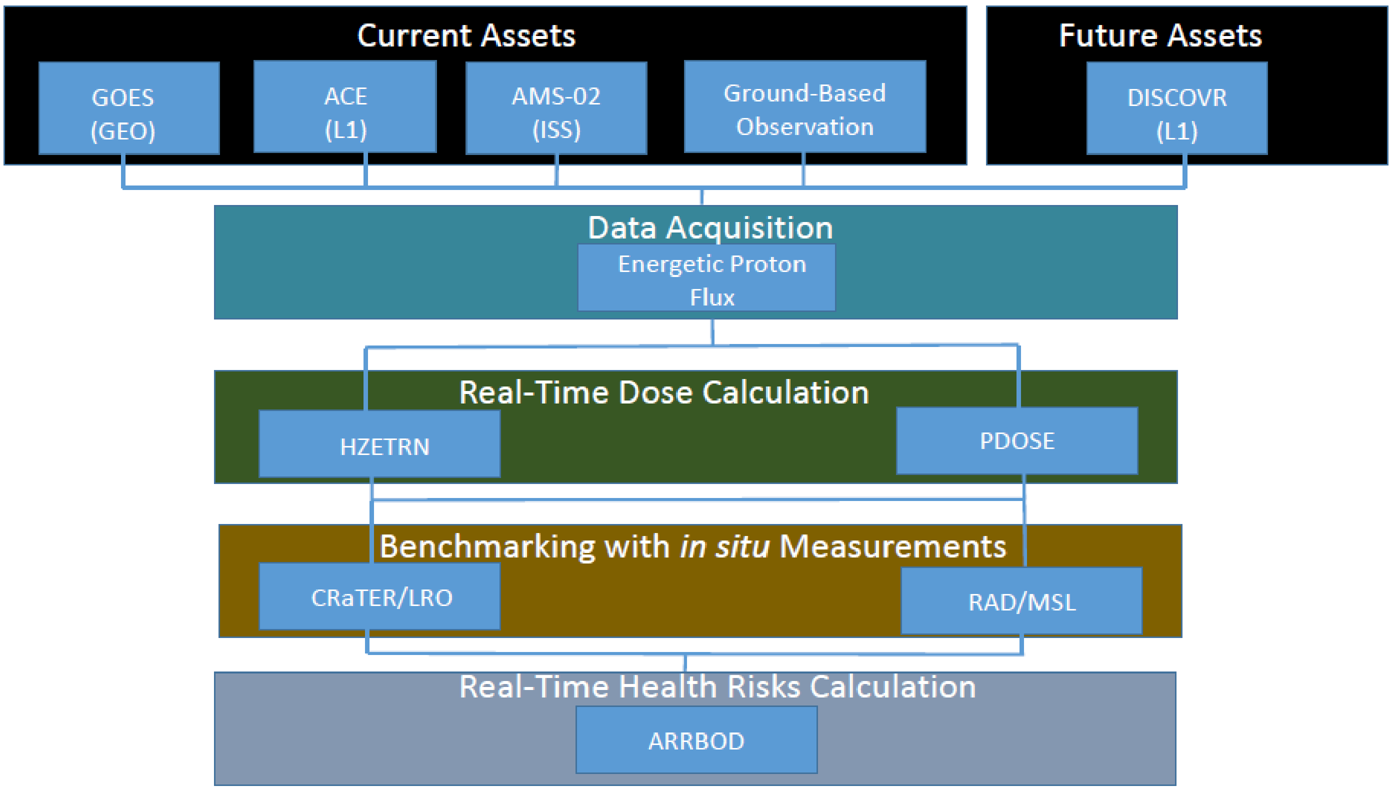

Diagram of processes to acquire data from multiple satellites and to do real-time dose calculation and risk estimation. GOES, ACE, AMS-02, DISCOVR, CRaTER/LRO, and RAD/MSL are instruments deployed in different locations in space, and HZETRN, PDOSE, and ARRBOD refer to modeling software packages that will be utilized in this project. Data acquisition from satellites will be guided by EJS of the Space Radiation Analysis Group (SRAG) of the mission operations directorate, PDOSE calculations and benchmarking comparison will be conducted by JEB of SRAG, and HZETRN calculations and benchmarking, as well as ARRBOD simulations will be conducted by SH of SRPE.